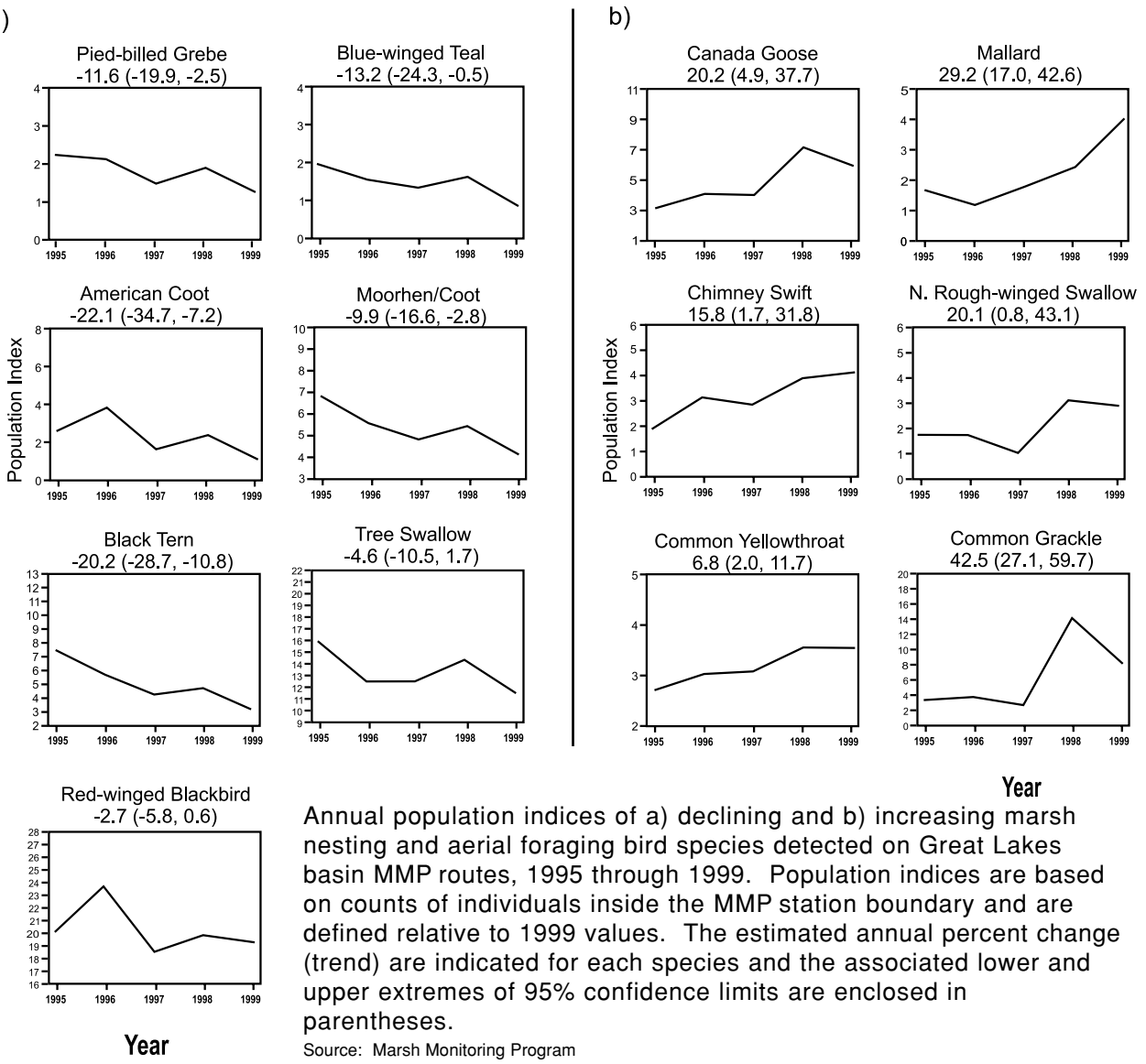


Annual population indices of a) declining and b) increasing marsh nesting and aerial foraging bird species detected on Great Lakes basin MMP routes, 1995 through 1999. Population indices are based on counts of individuals inside the MMP station boundary and are defined relative to 1999 values. The estimated annual percent change (trend) are indicated for each species and the associated lower and upper extremes of 95% confidence limits are enclosed in parentheses.

Source: Marsh Monitoring Program

Future Pressures

Continuing loss and degradation of important breeding habitats through wetland loss, water level stabilization, sedimentation, contaminant and nutrient inputs, and the invasion of non-native plants and animals will continue putting pressure on these bird populations.

Acknowledgments

Author: Russ Weeber, Bird Studies Canada, Port Rowen, ON.

The Marsh Monitoring Program is delivered by Bird Studies in partnership with Environment Canada's Canadian Wildlife Service and with significant support from the U.S. Environmental Protection Agency's Great Lakes National Program Office and Lake Erie Team. The contributions of all Marsh Monitoring Program staff and volunteers are gratefully acknowledged.

Coastal Wetland Area by Type

Assessment: Mixed, deteriorating

Purpose
The purpose of this indicator is to examine and better understand periodic changes in area of coastal wetland types, taking into account natural variations in areal extent and changes within wetlands.

State of the Ecosystem
Wetlands continue to be lost and degraded, yet the ability to track and determine the extent and rate of this loss in a standardized way is not yet feasible.

Adding up the area of individual wetlands from the Ontario Coastal Wetland Atlas will provide an initial estimate of the total Canadian Great Lakes coastal wetland area. This process is unlikely to be repeated, however, since it is labour intensive, expensive, and covers a very large geographic area.

Other methods to look at trends in coastal wetland area rely on remotely sensed data. For example, the U.S. Fish and Wildlife Service published the National Wetland Inventory (NWI) in 1982, based on the analysis of aerial photographs with ground-truth. The NWI includes delineated wetland types with updates to be prepared every 10 years. The first one was in 1990. Updates are based on a statistical sampling of wetlands, not on a full set of aerial photos. The NWI, however, does not specifically identify coastal wetlands.

Numerous research efforts are underway to assess the use of remote sensing technologies, and in some cases combine the results of satellite remote sensing, aerial photography and field work to document recent wetland loss. In the future, remote sensing will be used to provide an overview and facilitate a binational map of Great Lakes coastal wetlands as well as to establish a consistent methodology for tracking change and to facilitate faster updates in areas of high land-use change.

Future Pressures
Reductions in wetland area are continuing from filling, dredging and draining for conversion to other uses such as urban, agricultural, marina, and cottage development; shoreline modification; water level regulation; sediment and nutrient loading from watersheds; adjacent land use; non-native invasive species; and climate variability and change.

Acknowledgments

Authors: Lesley Dunn, Canadian Wildlife Service, Environment Canada, Downsview, ON and Laurie Maynard, Canadian Wildlife Service, Environment Canada, Guelph, ON.

Contributions from Doug Forder, Canadian Wildlife Service, Environment Canada, Duane Heaton, U.S. Environmental Protection Agency, Linda Mortsch, Meteorological Service of Canada, Environment Canada, Nancy Patterson, Canadian Wildlife Service, Environment Canada and Brian Potter, Ontario Ministry of Natural Resources.

Effects of Water Level Fluctuations

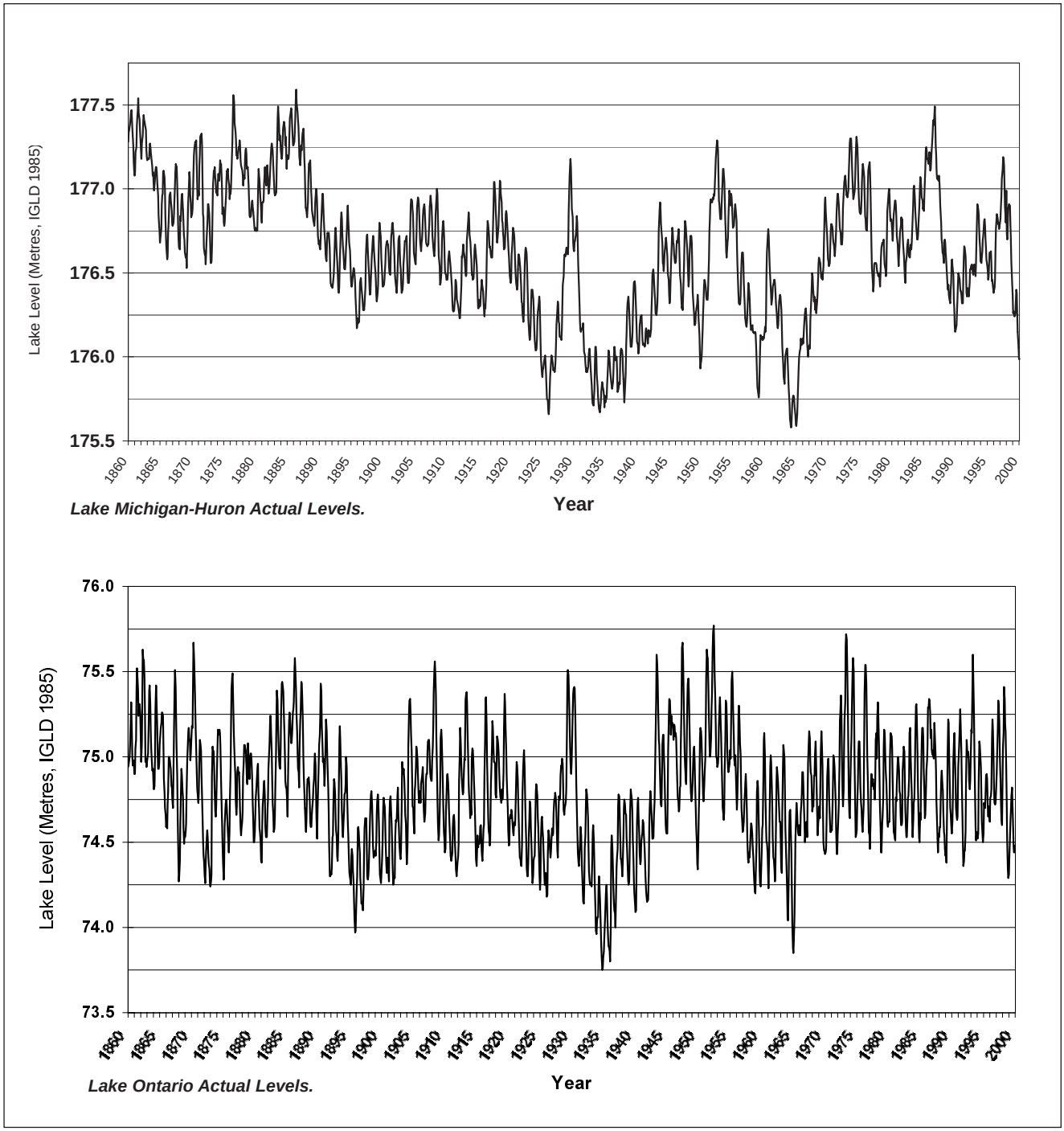
Assessment: Mixed, deteriorating

Purpose
The purpose of this indicator is to assess the lake level trends that may significantly affect components of wetland and nearshore terrestrial ecosystems, and to infer the effect of water level regulation on emergent wetland extent.

State of the Ecosystem
Quasi-periodic lake level fluctuations, both in period and amplitude, occur on an average of about 160 years, with sub-fluctuations of approximately 33 years. The levels in Lakes Michigan and Huron show the characteristic high and low water levels. Data for Lake Ontario show these fluctuations, but their amplitude has been reduced since the Lake level began to be regulated by various dams in 1959.

During periods of high water, there is a die-off of species that cannot tolerate long periods of increased depth of inundation. As the water levels recede, seeds buried in the sediments germinate and vegetate the newly exposed zone. During periods of low water, woody plants and emergents become established. This is the 'normal' relationship between wetlands and fluctuating water levels.

Under more stable water levels, such as in Lake Ontario, coastal wetlands occupy narrower zones along the Lakes and are considerably less diverse because dominant species such as cattails take over.



Actual water levels for Lakes Huron and Michigan (upper) and Lake Ontario (lower).

IGLD-International Great Lakes Datum. Zero for IGLD 1985 is Rimouski, Quebec, at the mouth of the St. Lawrence River. Water level elevations in the Great Lakes/St. Lawrence River system are measured above water level at this site.

Source: National Oceanic and Atmospheric Administration

Future Pressures

Future pressures include additional withdrawals or diversions of water from the Lakes; additional regulation or smoothing of the high and low water levels; and global climate variability and change.

Acknowledgments

Author: Duane Heaton, U.S. Environmental Protection Agency, Chicago, IL.

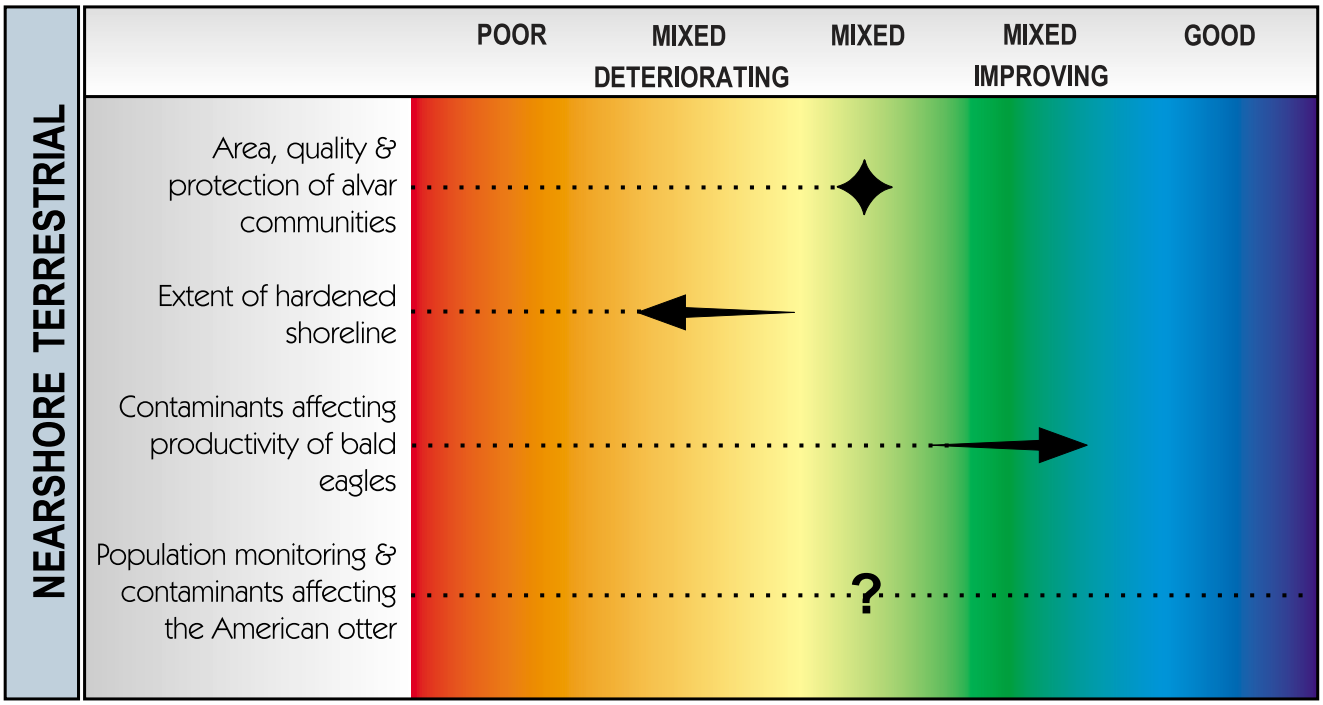
Contributions from Douglas A. Wilcox, U.S. Geological Survey, Biological Resources Division, Todd A. Thompson, Indiana Geological Survey, and Steve J. Baedke, James Madison University.

Time series at Fish Point (east shore of Saginaw Bay, Lake Huron) from 1988 to 1993 showing the effects of fluctuating water levels on a coastal wetland.

Photo credits: Douglas A. Wilcox, U.S. Geological Survey

3.3 Nearshore Terrestrial

Nearshore Terrestrial Indicators - Assessment at a Glance



Area, Quality and Protection of Alvar Communities

Assessment: Mixed

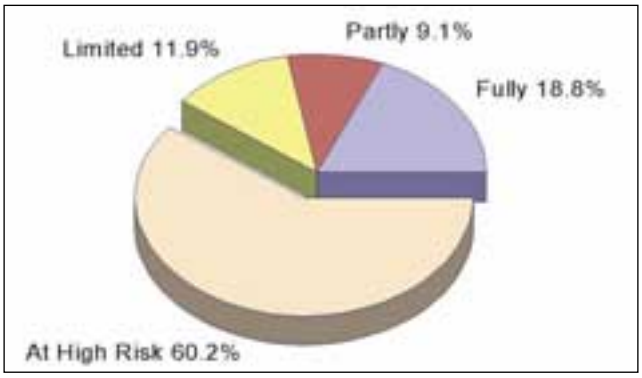
Purpose

This indicator assesses the status of one of the 12 special lakeshore communities identified within the nearshore terrestrial area. Alvar communities are naturally open habitats occurring on flat limestone bedrock.

State of the Ecosystem

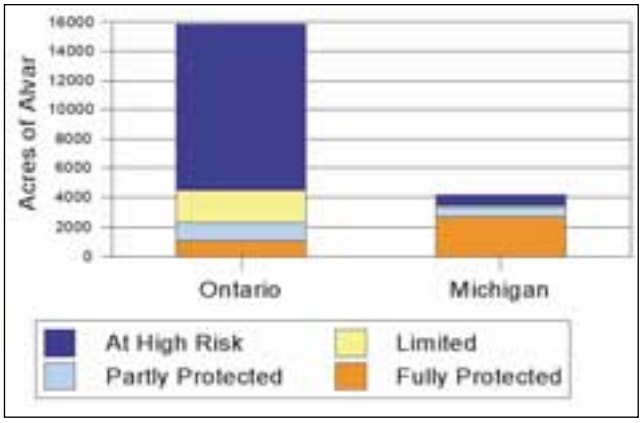
More than 90% of the original extent of alvar habitats has been destroyed or substantially degraded. Emphasis is focused on protecting the remaining 10%. Approximately 64% of the remaining alvar area exists within Ontario, 16% in New York State, 15% in Michigan, and smaller areas in Ohio, Wisconsin and Quebec.

Less than 20% of the nearshore alvar acreage is currently fully protected, while over 60% is at high risk. Michigan has 66% of its nearshore alvar acreage in the Fully Protected category, while Ontario has only 7%. In part, this is a reflection of the much larger total shoreline acreage in Ontario.



Protection status 2000. Nearshore alvar acreage.

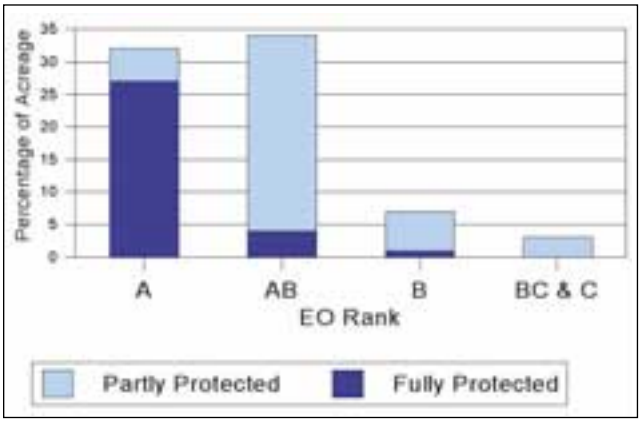
Source: Ron Reid, Bobolink Enterprises



Comparison of acreage protected. Nearshore alvars: Ontario and Michigan.

Source: Ron Reid, Bobolink Enterprises

Each alvar community occurrence has been assigned an "EO (Element Occurrence) rank" to reflect its relative quality and condition. (EO ranks summarize the quality and condition of each individual alvar community at a site, based on standardized criteria for size, site condition, and landscape content.) A and B-ranks are considered viable, while C-ranks are marginal and D ranks are poor. Protection efforts to secure alvars have clearly focused on the best quality sites. Recently, 10 securement projects have resulted in protection of at least 5,289 acres of alvars across the Great Lakes basin.



Protection of high quality alvars.

Source: Ron Reid, Bobolink Enterprises

Future Pressures

Continuing pressures on alvars include habitat fragmentation and loss; trails; off-road vehicles; resource extraction uses such as quarrying or logging; adjacent land uses such as residential subdivisions; grazing or deer browsing; plant collecting for bonsai or other hobbies; and invasion by non-native plants.

Acknowledgments

Authors: Ron Reid, Bobolink Enterprises, Washago, ON, and Heather Potter, The Nature Conservancy, Chicago, IL.

Extent of Hardened Shoreline

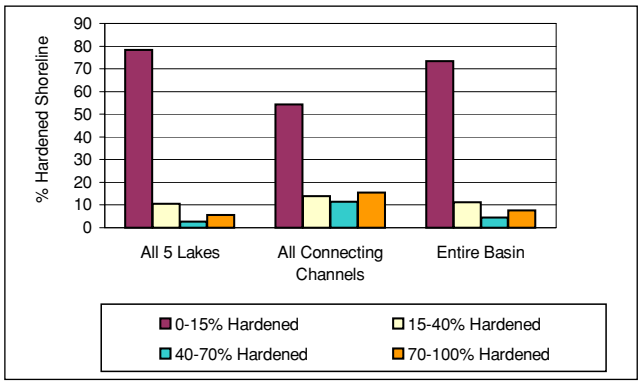
Assessment: Mixed, deteriorating

Purpose

This indicator assesses the extent of hardened shoreline through the construction of sheet piling, rip rap, or other erosion control structures. Shoreline hardening not only directly destroys natural features, but also disrupts biological communities that are dependent upon the transport of shoreline sediment by lake currents. Hardening also destroys inshore habitat for fish, birds and other biota.

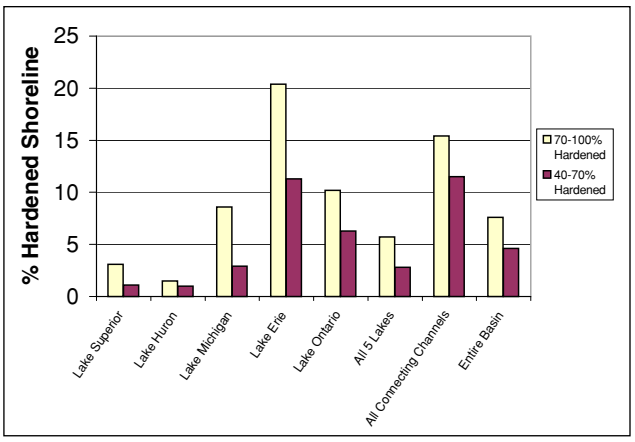
State of the Ecosystem

The St. Clair, Detroit, and Niagara Rivers have a higher percentage of their shorelines hardened than anywhere else in the basin. Of the Lakes



Shoreline hardening in the Great Lakes (compiled from 1979 data for the state of Michigan and 1987-1989 data for rest of the basin).

Source: Environment Canada and National Oceanic and Atmospheric Administration



Shoreline hardening by lake (compiled from 1979 data for the state of Michigan and 1987-1989 data for rest of the basin).

Source: Environment Canada and National Oceanic and Atmospheric Administration

themselves, Lake Erie has the highest percentage of its shoreline hardened, and Lakes Huron and Superior have the lowest.

Along about 22 kilometres of the Canadian side of the St. Clair River, an additional 5.5 kilometres (32%) of the shoreline had been hardened over the 8-year period from 1991 to 1999. This rate of hardening is not representative of the overall basin, however. The St. Clair River is a narrow shipping channel with high volumes of Great Lakes traffic, and many property owners are hardening the shoreline to reduce the impacts of erosion.

Future Pressures

Shoreline hardening can be considered a permanent feature and additional stretches of shoreline will be hardened, especially during periods of high lake levels. This additional hardening will, in turn, starve the downcurrent areas of sediment to replenish the eroded materials and causes further erosion and further incentive for additional hardening.

Acknowledgments

Authors: John Schneider, U.S. Environmental Protection Agency, Great Lakes National Program Office, Chicago, IL, Duane Heaton, U.S. Environmental Protection Agency, Great Lakes National Program Office, Chicago, IL, and Harold Leadlay, Environment Canada, Environmental Emergencies Section, Downsview, ON.

Contaminants Affecting Productivity of Bald Eagles

Assessment: Mixed, improving

Purpose

This indicator assesses the number of fledged young, number of developmental deformities, and the concentrations of organic contaminants and heavy metals in bald eagle eggs, blood, and feathers. The data will be used to infer the potential for harm to other wildlife and human health through the consumption of contaminated fish.

State of the Ecosystem

The concentrations of p,p-DDE, total PCBs, and mercury in blood plasma and feathers of nestling bald eagles in Michigan are either stable or declining from concentrations observed in the late 1980s and early 1990s. The majority (>95%) of eggs tested, however, exhibited contaminant concentrations greater than No Observed Adverse Effects Concentrations (NOAECs) for PCBs and p,p'-DDE, and the number of observed developmental deformities has increased over time.

Approximate nesting locations of bald eagles along the Great Lakes shorelines, 2000.

Source: W. Bowerman, Clemson University, Lake Erie and Lake Superior LaMPs, and for Lake Ontario, Peter Nye, NY Department of Environmental Conservation

The number of nestling eagles fledged from nests along the shorelines of the Great Lakes has steadily increased from six in 1977 to over 200 in 2000, including the first record of a nesting pair along the shoreline of Lake Ontario.

Future Pressures
Pressures on bald eagles include continued exposure, through food chain mechanisms, to environmental pollutants; human related disturbances near nest sites; food availability; loss of habitat due to development; and the loss of protection after delisting from the U.S. Endangered Species list. For those eagles nesting above barrier dams, there is the potential for fish passage of contaminated Great Lakes fishes.

Acknowledgments

Authors: William Bowerman, Clemson University, David Best, U.S. Fish & Wildlife Service, and Michael Gilbertson, International Joint Commission.

Population Monitoring & Contaminants Affecting the American Otter

Assessment: Insufficient data to assess

Purpose
This indicator directly measures the contaminant concentrations found in American otter populations within the Great Lakes basin, and it indirectly measures the health of Great Lakes habitat, progress in Great Lakes ecosystem management, and/or concentrations of contaminants present in the Great Lakes.

State of the Ecosystem
General otter population indices derived from state and provincial data indicate that primary areas of suppression still exist in western Lake Ontario watersheds, southern Lake Huron watersheds, lower Lake Michigan and most Lake Erie watersheds. Data suggest that otter are almost absent in western Lake Ontario. Most coastal shoreline areas have more suppressed populations than interior zones and Great Lakes drainage populations.

Areas of otter population suppression are directly related to human population centres and subsequent habitat loss.

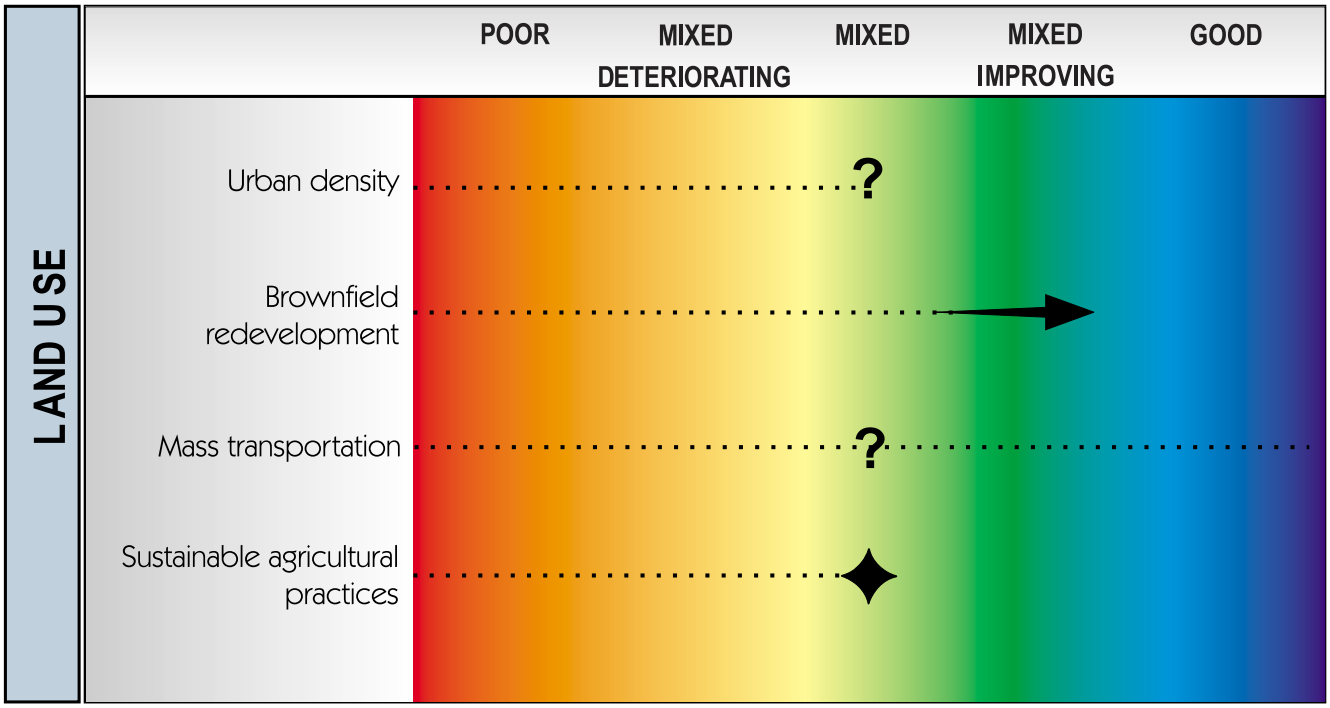
Future Pressures
Otter will continue to be under pressure from organic and heavy metal concentrations in the food chain, and anthropogenic alterations of river and lake habitats.

Acknowledgments

Author: Thomas C.J. Doolittle, Bad River Tribe of Lake Superior Chippewa Indians, Odanah, WI.

3.4 Land Use

Land Use Indicators - Assessment at a Glance

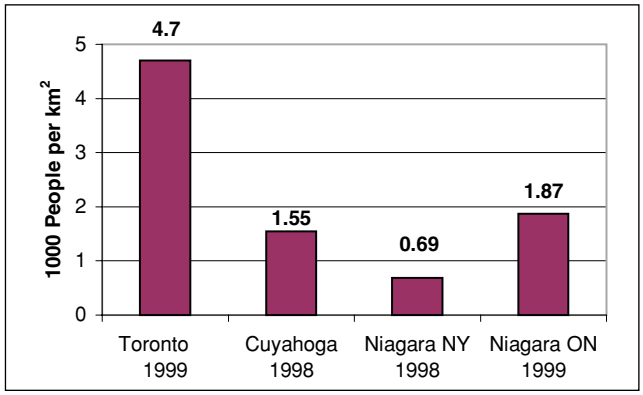


Urban Density

Assessment: Unable to assess status until targets are determined

Purpose
This indicator measures human population density and indirectly measures the degree of inefficient land use and urban sprawl for communities in the Great Lakes basin. The number of people that inhabit a community relative to its size is an indicator of the economic efficiency of that community based on the existence of 'economies of scale' associated with high density development.

State of the Ecosystem
There are marked differences around the Great Lakes basin in communities' urban densities. Initial research compared the larger more established urban cities of Toronto, Ontario and Cuyahoga County, Ohio (which includes Cleveland) and the two smaller communities of the Regional Municipality of Niagara, Ontario and Niagara County, New York. Factors such as ongoing 'rust belt' U.S. population



Urban densities in four Great Lakes urban communities.
Source: Rivers Consulting and J. Barr Consulting

declines may be partly responsible for the statistical differences in urban densities.

Trends over the last ten years indicate that population densities are increasing in both of the Canadian communities sampled and are stable to declining in the U.S. communities.

Future Pressures
Continued urban sprawl and low density development throughout the basin represent significant pressures.

Acknowledgments

Authors: Ray River, Rivers Consulting, Campbellville, ON, and John Barr, Burlington, ON.

Brownfields Redevelopment

Assessment: Mixed, improving

Purpose
This indicator assesses the acreage of redeveloped brownfields, and it is used to evaluate over time the rate at which society rehabilitates and reuses former developed sites that have been degraded or abandoned.

State of the Ecosystem
Information on acres of brownfields remediated from Illinois, Minnesota, New York, and Pennsylvania indicates that a total of 28,789 acres of brownfields have been remediated in these jurisdictions alone. Available data from six Great Lakes states indicate that more than 8,662 brownfield sites have participated in brownfields cleanup programs. Though there are inconsistent and inadequate data on acres of brownfields remediated and/or redeveloped, available data indicate that both brownfields cleanup and redevelopment efforts have risen dramatically since the mid 1990s. This is due to the new wave of risk-based cleanup standards and widespread use of state liability relief mechanisms that allow private parties to redevelop, buy or sell property without being held liable for contamination they did not cause. Data also indicate that the majority of cleanups in Great Lakes states and provinces are occurring in older urbanized areas, many of which are located on the Great Lakes and in the basin. Based on this information, the state of brownfields redevelopment is good and improving.

Brownfield site in Detroit, Michigan, 1998.
Photo Credit: Victoria Pebbles, Great Lakes Commission

Future Pressures
Continued pressures include: lack of long-term monitoring and enforcement of exposure controls (examples of exposure control include capping a site with clean soil or restricting the use of ground water); cleanup standards based on risks to human health that may not be appropriate for habitat creation/enhancement; the potential for contaminated groundwater to interface with surface waters and cause degradation of surface waters; and policies that encourage new development to occur outside already developed areas over urban brownfields.

Acknowledgments

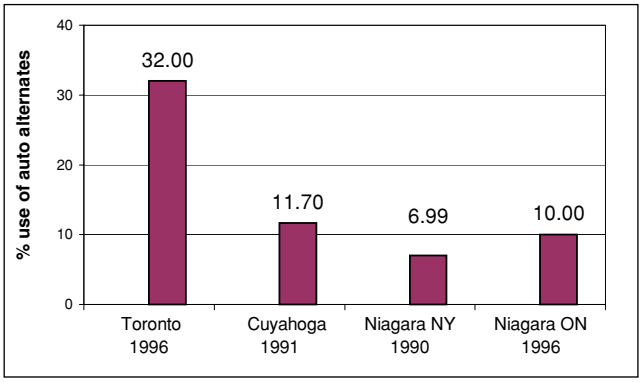
Author: Victoria Pebbles, Great Lakes Commission, Ann Arbor, MI.

Mass Transportation

Assessment: Unable to assess status until targets are determined

Purpose
This indicator measures the percentage of daily commuters that use public transportation or other alternatives to the private car. It indirectly measures the stress to the Great Lakes ecosystem caused by the use of the private motor vehicle and its resulting high resource utilization and creation of pollution.

State of the Ecosystem
There are marked differences amongst four sample Great Lakes basin communities in automobile usage for commuting. Initial research showed that there is a direct relationship between public transportation and the degree of urban density. Higher usage of transportation alternatives occurs within the larger more established urban cities of Toronto, Ontario and Cuyahoga County, Ohio (which includes Cleveland) than within the more lightly populated and smaller communities of the Regional Municipality of Niagara, Ontario and Niagara County, New York. This relationship was pronounced in Toronto where higher density also facilitated greater use of bicycling and walking amongst urban commuters.



Percentage of commuters using alternatives to automobiles in selected communities.

Source: Rivers Consulting and J. Barr Consulting

Future Pressures
Significant pressures arguing for more mass transportation are population growth combined with urban sprawl.

Acknowledgments

Authors: Ray Rivers, Rivers Consulting, Campbellville, ON, and John Barr, Burlington, ON.

Sustainable Agricultural Practices

Assessment: Mixed

Purpose
This indicator assesses the number of Environmental and Conservation farm plans and environmentally friendly agricultural practices in place, such as integrated pest management to reduce the potential adverse impacts of pesticides, and conservation tillage and other soil preservation practices to reduce energy consumption, prevent ground and surface water contamination, and achieve sustainable natural resources.

State of the Ecosystem
Agriculture accounts for 35% of the land area of the Great Lakes basin and dominates the southern portion of the basin. In the past, excessive tillage and intensive crop rotations led to soil erosion and the resulting sedimentation of major tributaries. Agriculture is a major user of pesticides with an annual use of 26,000 tons. These practices led to a decline of soil organic matter. Recently there has been increasing cooperation between government and the farm community on Great Lakes water quality management programs. The adoption of more environmentally responsible practices has helped to replenish carbon in the soils back to 60% of turn-of-the-century levels.

Both the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) and the USDA's Natural Resources Conservation Service (NRCS) provide conservation planning advice, technical assistance and incentives to farm clients and rural landowners. On a voluntary basis clients develop and implement conservation plans to protect, conserve, and enhance natural resources that harmonize productivity, business objectives and the environment.

Future Pressures
Sustainable agricultural practices will be compromised by increasing farm size and concentration of livestock; changing land use and development pressures (including higher taxes), traffic congestion, flooding and pollution.

Acknowledgments

Authors: Roger Nanney, U.S. Natural Resources Conservation Service, Chicago, IL, and Peter Roberts, Ontario Ministry of Agriculture, Food and Rural Affairs, Guelph, ON.